IOWA WEATHER REPORT.—We observe from a circular issued by Prof. Gustavus Henrichs to the volunteer observers of Iowa (U.S.), that his report of the observations made at the meteorological stations of that State during 1876 is to be published as an Appendix to the *Report of the Iowa State Agricultural Society*, and that as the monthly reports are published in fully twenty of the newspapers, the *Weather Review* will be discontinued. The *Weather Report* about to be published will embrace an account of the meteorological system now in full operation over the State, and discussions of the rainfall, storms, and other phenomena, the normals which have been ascertained for different localities, and the detailed observations made at the Central Weather Station.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SATELLITE, HYPERION.—Prof. Asaph Hall, in *Astron. Nach.*, No. 2,137, publishes an ephemeris of this faint object about the approaching opposition of Saturn, with the view to facilitate observations, especially near the conjunctions. He remarks that although the satellite was discovered (by Bond and Lassell) nearly thirty years since, the difficulty of observing it has been so great that no satisfactory determination of its orbit has been practicable; most of the observations being made near the elongations, the position of the plane of the orbit is not accurately deducible therefrom, though it probably does not coincide with the plane of the ring, but appears to lie between those of Titan and Japetus. With the view to assist observation in the present year Prof. A. Hall has calculated elements from his observations in 1875, which may be stated as follows:—Perisaturnium passage, 1875, August 24·0036 mean time at Washington; distance of perisaturnium from the node 40° 0′, eccentricity 0·125, semi-axis major 214″·22, period of revolution 21·3113 mean solar days. For the reason stated above it is supposed for this approximate orbit that its plane coincides with that of the ring, the node of which on the earth's equator is assumed to be in 126° 9′·1, and its inclination thereto 7° 3′·8. From these data auxiliary quantities and an ephemeris for Washington midnight, August 1–September 15, are added, and it is suggested that with the aid of the former comprising the interval June 1–December 28 a more accurate calculation may be made by Mr. Marth's formulæ.

Taking the solar parallax at 8″·86 Prof. A. Hall's elements would give for the mean distance of Hyperion from the centre of Saturn 914,000 miles, distance in perisaturnium 800,000, in aposaturnium 1,028,000 miles.

The first computation of the orbit of this satellite was by the late Prof. G. P. Bond, of Cambridge, U.S., from his distances observed between 1848, September 19, and January 12 following; his period of revolution is 21·18 days, mean distance 214″, eccentricity 0·115; the elements will be found in the *Proceedings* of the American Academy of Arts and Sciences.

THE TRIPLE-STAR 7 CAMELOPARDI.—The third component of this triple star was detected by Baron Dembowski on September 28, 1864, having been overlooked by Struve at Dorpat, who measured A and B in 1831, his mean result being 1831·57, pos. 238·32°, dist. 25·647″. The Galarate epoch for the new companion is (A C) 1865·33 pos. 308°·83, dist. 1″·245. Baron Dembowski says the object was one of great difficulty for his refractor principally on account of the sombre hue of the star C, which did not appear always of the same intensity; referring to his observations at the epoch 1865·25, he remarks, "Elle avait alors une couleur de cendre mouillée; je n'ai jamais vue d'étoile aussi sombre.' His magnitudes of C in 1864-5 vary from 7·0 to 9·0, while in the middle of November, 1865, he could not perceive the least trace of the star. Mr. Crossley measured A B at the end of December, 1873, but has no reference to the third star. The object will be worth watching on the score of variability and the unusual duskiness noted by the Galarate observer.

THE CAPE ASTRONOMICAL RESULTS FOR 1874.—Mr. Stone has just circulated his volume of observations made at the Royal Observatory, Cape of Good Hope, in 1874, being the thirteenth separate publication which has emanated from this important and active astronomical establishment since the year 1871, when Mr. Stone undertook its direction. We believe there is not a refinement in observing or computing which is not introduced into the Cape work, and the results have consequently a very high value, comparable with the best work of the kind published by the great European and American observatories, where attention is given to stellar astronomy. The volume for 1874 contains the mean positions of 1,246 stars, including all Lacaille's stars of the *Cœlum Australe Stelliferum*, which now fall between 155° and 165° of north polar distance, and some additional ones in the same zone. Lacaille's stars between N.P.D. 145° and 155° were similarly observed in the course of the year 1875, and those between N.P.D. 135° and 145° in 1876, the reductions to mean places for the former zone having been completed at the beginning of the present year. A complete determination of the accurate places of all Lacaille's stars, founded on the Cape observations, is therefore in a very forward state.

As an appendix to this volume of Cape Observations, Mr. Stone presents tables intended to facilitate the computation of star-constants, which appear likely to prove of very great service to the practical astronomer. By a slight modification of Bessel's form for star-corrections he has been able to tabulate the quantities in a very convenient and compendious manner, so that the whole computation occupies but a short time. Mr. Stone hopes that the use of these tables may render it unnecessary to give star-constants for every star contained in future catalogues, the labour of forming which, and of insuring their accuracy is very great. It is probable, as he observes, that the use of star-constants in various catalogues has been in many cases extended beyond the time when they could be introduced with a due regard to the precision required in modern stellar astronomy, which will be obviated by the use of the tables in question. It is understood that Mr. Stone liberally offers to supply a copy of these tables to anyone who would find them of real service, and who will make application for them. A few remarks on the *modus operandi* with the tables are reserved for a future column.

THE BRITISH ASSOCIATION AT PLYMOUTH

FEW towns in the United Kingdom have so much to interest alike the scientific and the general visitor as Plymouth; and the meeting there of the members of the British Association in August next should prove alike pleasant and profitable. For the general visitor it will perhaps be enough that the Plymouth Hoe is one of the finest promenades in England, and that the landscapes of the neighbourhood are at once most varied and most attractive. The man of science will be able to enjoy all this and a good deal more. The zoologist may if he pleases revel in dredging expeditions in and off the Sound, which are sure to yield an ample reward. For the mechanician there are three of the most no able works of modern engineering skill to inspect—the Eddystone Lighthouse, the Plymouth Breakwater, and the Royal Albert Bridge, while the Government dockyards and factories at Devonport and Keyham, and the war vessels which stud the Hamoaze, will have a general as well as a special interest. One of the most enjoyable excursions of the Exeter meeting was that to the Three Towns, on which occasion the Government establishments were visited and gunnery and torpedo practice, with all the latest electrical

arrangements, witnessed on board the *Cambridge*. The science of war has by no means stood still since then. The botany of the locality presents some peculiar features, and the algology is very rich.

In the domain of natural science special interest however attaches to the local geology. Plymouth rivals Torquay in its development of the great Devon limestone, which lines the northern borders of the twin estuaries of the Tamar and the Plym, along which the Three Towns are built, and trending southward and eastward, occupies the northern shores of Cattewater, and after a break reappears in mass at Yealmpton. The Hoe is limestone—a natural esplanade, an ancient plateau of denudation, with occasional alluvial deposits of sand and clay in pockets and fissures, remains of raised beaches, and a few ossiferous cavities. The limestone abounds in fossils, coralline in the more massive portions as a rule, but with areas crowded with molluscs of the ordinary Devonian type. Its chief palæontological interest lies, however, in its bone caves. The ossiferous caverns of Oreston, a little village on the southern bank of Cattewater, which were discovered originally in the course of quarrying the stone for the breakwater, whilst other members of the series have been opened from time to time since, are well known by description at least to geologists. Those of Yealmpton have hardly attracted so much attention. The fauna differs in both series in some important particulars from that of Kent's Cavern, though including in each case the ordinary cavern carnivora. The whole literature of the Oreston and Yealmpton caverns will be found in the *Transactions* of the Devonshire Association, compiled by Mr. Pengelly. And if the palæontologist should then feel special interest in a locality which has yielded so much to his branch of science, the stratigraphical geologist will find some notable materials for the study of the "still-vexed Devonian question" in the sections along the eastern shore of the Sound and elsewhere. The cliff section from Mount Batten, by Staddon Heights and Bovisand to the mouth of the Yealm has been described by Sedgwick, Murchison, de la Beche, Phillips, Holl, Pengelly, Jukes, and other eminent geologists, and interpreted very diversely, though the balance of opinion still remains that its shales and sandstones overlie the limestone. The contortions and plications are, however, in some parts very remarkable, and should be studied *in situ*.

There is nothing very noteworthy in the immediate mineralogy of Plymouth, but the mining districts of Cornwall and Devon, within easy reach, are the richest mineralogical field in the kingdom, and in the barrows circles, cromlechs, pounds, dolmens, and menhirion, still scattered in profusion over the wild flanks of Dartmoor, and along many a Cornish moorland, the anthropologist will find plenty to delight him. Upon the importance of the contributions of Kent's Cavern to the early history of man we need not dilate. The results of the explorations there, with the literature of the cavern, prepared by the indefatigable pen of Mr. Pengelly, will be found in the Devonshire Association *Transactions*.

The Plymouth Institution, with which is amalgamated the Devon and Cornwall Natural History Society, and which fittingly took the initiative in proposing the invitation of the Association, is the centre of the scientific life and work of the neighbourhood. It is a society of some standing, for it was founded so far back as the year 1812, and its members have done much to elucidate science in its connections with the district, and to cultivate literature and the fine arts. The natural history section of its museum is rich in local ichthyology, and fair in some other departments of its fauna. There are some very valuable antiquities; and the mineralogical and geological collections, though far from complete, are by no means wanting in interest. Bones from the ossiferous fissures on the Hoe, the caverns at Oreston and Yealmpton, and from Kent's Hole, form a prominent feature of its palæontology; and there are a few specimens which have a special value in having been presented by the Rev. Richard Hennah, who first established the fossiliferous character of the Plymouth limestone. The Institution issues *Transactions*, and has published some valuable papers bearing alike on science and upon local history, topography, and literature, from the "Law of Electrical Accumulations," by Sir W. Snow Harris, F.R.S.; to a paper "On the Letter R," by R. F. Weymouth, D.Lit. It will be evident, therefore, that the institution has been doing good work.

But now for some particulars concerning the local arrangements. These are in the hands of a large and influential executive committee, with sub-committees for the chief departments—finance, reception, sectional, excursion, fine art, &c. The mayor is the chairman of the executive; the secretaries being Messrs. W. Adams, W. Square, and H. Whiteford, while Mr. F. Hicks is the treasurer.

In one respect, and that a most important one, Plymouth will distance almost every town the Association has visited. We allude to the convenience of its sectional accommodation. The great hall of the Plymouth Guildhall, with its royal statues and magnificent historic windows, is the noblest hall in the whole south and west of England. Here the president will deliver his address and the evening meetings be held. In the law courts adjoining, and the spacious rooms of the municipal offices, some of the sections will be accommodated. Others will meet at the Mechanics' Institute, the Athenæum, and the Royal Hotel, the whole of which are within less than five minutes' walk of the Guildhall and each other. Since one or two of the other section rooms were decided on, it has been suggested that the sections to which they were appropriated may also be accommodated within the limits first indicated; but whether that be so or not, in the most remote case the most distantly located sections will only be six or seven minutes' walk apart. The members of the Association will know how to appreciate this.

Close by the Guildhall is St. Andrew's Hall, a large building recently erected as a skating rink. This will be utilised in connection with the Association for an exhibition of the fine arts. Plymouth is the artistic centre of Devon and Cornwall, which have given birth to many famous painters, and the exhibition is intended to be specially representative of western art. The Queen is among the contributors, and leading residents throughout the two counties. Living artists will be well represented; but the staple of the exhibition will consist of examples of Reynolds, Opie, Eastlake, Prout, with Haydon, Northcote, and other artists of note. With the exception of Opie, who was a Cornishman, and Reynolds, who was born at Plympton, four miles off, the artists here named are Plymothians.

Every effort is being made to get up an enjoyable and scientifically interesting series of excursions. It is perhaps rather a disadvantage in one way that the neighbourhood of Plymouth should be so beautiful, for therein lies a strong temptation to let fine scenery get the better of hard science. However, it so happens that there is very little difficulty in combining both. In 1841 there was but one excursion—to Tavistock and Wheal Friendship. This year there are six proposed—three for the Saturday and three for the Thursday following, in addition to which the Earl of Mount-Edgcumbe has most kindly consented to open his magnificent park on the Saturday to the members. The botanists will need no excuse for visiting Mount-Edgcumbe; if the geologists do they may find it in the interesting intrusive rocks at Cawsand, referred to in De la Beche's Report. One of the excursions proposed for Saturday is by steamer to the breakwater, and Smeaton's famous work, the Eddystone Lighthouse,

winding up with a trip round the harbour, with its men-of-war, dockyards, forts, and factories. The Government establishments are always open to English folk. Our foreign friends who may desire to go over them, will have to provide themselves with a special order. There will be also a trip to Liskeard, for the Caradoc and Phœnix mines, and the famous Cheesewing. As mining is the special industry of Cornwall, and to a great extent of South Devon, it has been thought desirable to have two mining excursions—one on each day. South Caradoc is one of the richest copper mines in Cornwall; Phœnix is a tin mine; and both are admirably managed and excellently adapted to illustrate mining operations. The mineralogy of this district has some peculiar features. Phœnix has lately yielded the rare minerals chalcosiderite, andrewsite, and the beautiful turquoise-hued henwoodite. The third excursion will be to the Lee Moor China clay works. These are situated on the skirts of Dartmoor, not far from Plympton, are of immense size, and afford probably the best illustration of this great industry, which Cornwall and Devon owe to the researches and ingenuity of Cookworthy, chemist and potter, manufacturer in the Plymouth china of the first true English (hard) porcelain. It is likely that this excursion will be taken up by the Plymouth Institution, and so arranged as to embrace a visit to Princetown, and its convict prison, and some of the fine prehistoric antiquities of Dartmoor; if not there will probably be an extra excursion with this object given by the institution.

Thursday will be a long day, and wholly given up to excursion pleasures. The mining excursion will be up the lovely river Tamar to Devon Great Consols, which communicates by a railway of its own to shipping quays at Morwellham, in the close vicinity of the most picturesque scenery of the Tamar valley. On the way, by the kindness of the Countess Dowager and the Earl of Mount-Edgcumbe, the party will have an opportunity of inspecting Cotehele, one of the most perfect examples of a mediæval mansion now extant. At Devon Consols—not long since the largest and richest copper mine in the land, which gave in dividends considerably over a million—not only are mining operations conducted on the most extensive scale, but there are enormous arsenic works, huge water-wheels, and many other objects of interest. The other excursions arranged for the day are to Torquay and Penzance. The good people of Torquay intend to follow the capital precedent set in 1869, and to invite and entertain a number of guests. *En route* from Plymouth a steamer trip may be made down the lovely river Dart; and at Torquay there are plenty of objects of interest. The Torquay Natural History Society has a well-stored museum; Kent's Cavern is of course a museum in itself, with a very Cerberus of a curator in Mr. Pengelly; and then there are the works of Mr. Froude, F.R.S., at Chelson Cross, where he conducts those delicate experiments for the Admiralty on the forms of ships and their properties of stability, and to which he intends to invite members of the Association who are specially interested in this branch of mechanical science. Steps are, we believe, being taken at Penzance to give the excursionists thither a hearty welcome. The museums of the Penzance Natural History Society and of the Royal Geological Society of Cornwall, the latter of which contains the best public mineralogical collection in the West of England will be thrown open to them, and excursions in all probability organised to the chief attractions of the neighbourhood. It is hoped to provide special railway facilities for those who may wish to visit other parts of the country—such as Tintagel or the Lizard, or the western mining district. At Truro is the excellent museum of the Royal Institution of Cornwall, which will be open to visitors.

The former meeting at Plymouth, of the Association, was in 1841, with Dr. Whewell, as president, and was a very successful gathering. Six-and-thirty years are a long time, and it is remarkable that so many who took a prominent part on that occasion are yet with us. One of the vice-presidents still survives—the Earl of St. Germans; two of the local secretaries, Mr. R. W. Fox, F.R.S., and Mr. R. Taylor, F.G.S.; a vice-president of the statistical section, the Earl Fortescue, then Viscount Ebrington; Dr. Owen, F.R.S., vice-president for Zoology and Botany; and Mr. Robert Hunt, F.R.S., then secretary of the section of Chemistry and Mineralogy, are still with us. There will not be wanting opportunity, therefore, of comparing personal experiences in 1841 and 1877.

INDIAN RAINFALL AND SUN-SPOTS

ON May 24 Gen. Strachey read a paper before the Royal Society entitled "On the alleged Correspondence of the Rainfall at Madras with the Sun-Spot Period, and on the True Criterion of Periodicity in a Series of Variable Quantities."

He stated that a paper had recently been printed by Dr. Hunter, the Director-General of Statistics to the Government of India, having for its object to show that the records of the rainfall at Madras, for a period extending over sixty-four years, establish a cycle of rainfall at that place which has a marked coincidence with a corresponding cycle of sun-spots—the rainfall and sun-spots attaining a minimum in the eleventh, first, and second years, and a maximum in the fifth year.

The Madras register extends over sixty-four years, beginning with 1813. The mean rainfall for the whole period is 48·5 inches. The deviations from the mean vary from 30·1 inches in defect to 39·9 inches in excess. The arithmetical mean of these deviations (disregarding the signs) is 12·4 inches.

Dr. Hunter divides the sixty-four years' observations into six cycles of eleven years, and calculates the arithmetical mean of the successive years of the whole series of cycles. The results are as follows:—

	Years of cycles of eleven years.										
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.
Average difference from the mean of 64 years.	in. +0·6	in. +0·7	in. +9·8	in. +2·4	in. +1·9	in. +5·8	in. +4·4	in. −3·4	in. −11·5	in. +0·7	in. −13·5

In the above calculation the first year of the cycle of eleven is 1813, so that the average period of maximum sun-spots will be about the third or fourth year of the cycle, and the period of minimum will be about the tenth or eleventh of the cycle. This table apparently indicates a period of maximum between the third and the seventh years, and of minimum between the eighth and the second years.

But as the only signification of the arithmetical mean value of a series of observed quantities is that it is one above and below which there is an equal amount of deviation in the individual observations, the question whether or not the mean values thus obtained can be accepted as showing a definite law of variation from year to year in the cycle must be determined by examining the differences between those means and the individual observations on which they are based.

Treating the observations in this manner, it appears that the mean difference of the individual observations from the means shown in the table amounts to 11·2 inches, and differs but little from the mean difference of the individual observations from the arithmetical mean of the whole series. In other words, the supposed law of variation obtained from the means of the six eleven-year cycles hardly gives a closer approximation to the actual observations than is got by taking the simple arithmetical mean as the most probable value for any year.

In order to obtain a practical test of the probable physical reality of the cycle of eleven years, the author calculated a series of mean values corresponding to those given in the table for a series of cycles of five, six, seven, eight, nine, ten, twelve, and fourteen years. The mean differences between these means and the observed quantities are all within a very small fraction of one another, and of the mean obtained from the eleven-year cycle—